The Relationship between Nursing Home Quality of Care and Potentially Preventable Hospitalization

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Abstract

Hospitalizations are very common among nursing home (NH) residents. Unfortunately many of these are deemed inappropriate or preventable. There is great variation in rates of potentially preventable hospitalization (PPH) across NHs beyond what can be explained by resident heterogeneity. Little is known about how NH quality of care is related to hospitalization, especially PPH. The purpose of this study was to examine the relationship between available quality indicators (QIs) and hospitalization and PPH among Medicaid beneficiaries aged 65 years and older receiving care at NHs in Minnesota. Twenty three risk-adjusted QIs were used to assess NH quality of care. Quality indicators and other facility-level variables from the Minnesota Nursing Home Report Card were merged with resident level variables from the Minimum Data Set. This merged data was linked with Medicaid claims to obtain the hospitalization information during the 2011 to 2012 period. Adjusted analyses controlled for resident and facility characteristics using the Generalized Linear Mixed Model. The results showed that about 44% of hospitalizations were PPHs. Available QIs were not strongly or consistently associated with the risk of hospitalization (neither overall nor PPH). Among these 23 QIs, only 6 QIs were related to hospitalization or death and only 4 were related to PPH. Most QIs did not capture the aspects of quality that directly related to hospitalization. Quality indicators and hospitalizations may tap different aspects of NH quality. Quality reform efforts based on improving performance on QIs may fail to result in large-scale reductions in hospitalization.

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1 Background

In the United States, more than 15,000 nursing homes (NHs) provide care to approximately 1.4 million residents (American Health Care Association, 2014). Because residents living in NHs are sicker and more medically complex than older people living in the community, appropriate management of their acute problems becomes an important component of nursing home quality of care (QOC). One common approach to managing acute conditions is to transfer residents into hospitals. Hospitalizations are very common among nursing home residents and unfortunately many of these are deemed inappropriate or preventable (Ouslander & Berenson, 2011). Besides generating excess healthcare cost, hospitalizations can be emotionally upsetting, and expose residents to additional risk factors, such as iatrogenic illness, hospital borne infections, deconditioning due to bed rest, disorientation, and discontinuity of NH care plan, without providing a substantial health benefit (Saliba et al., 2000).

To reduce hospitalizations among nursing home residents, on the hospital side, Centers for Medicare and Medicaid Services (CMS) has initiated the Hospital Readmission Reduction Program to reduce Medicare payments for hospitals with excess readmissions within 30 days. This regulation is intended to reduce hospitalizations by encouraging hospitals to improve post discharge management and use post-acute care effectively. Before this program, hospitals likely primarily considered the availability of beds when discharging patients to NHs and perhaps some measures of NH quality. Given the penalty, they must now consider NH hospitalization rates in addition to, or perhaps instead of, quality performance. Medicare's Nursing Home Compare website provides information about NH performance based on common quality indicators for short- and

long-stay residents. This information is designed to be used by consumers and other parties interested in quality. NHs will now be judged by two sets of measures: readmissions and quality indicators. If these two measures are strongly related, the problem is simple; good care can be rewarded. But if the two are not correlated, nursing facilities face a dilemma about where to put their efforts.

1.1 Potentially Preventable Hospitalization

The term potentially preventable hospitalization (PPH) has different names in the literature; it basically refers to hospitalizations that are preventable, avoidable, discretionary, or unnecessary. The concept of PPH is based on ambulatory care sensitive (ACS) conditions. This designation does not mean that persons with these conditions should never be hospitalized, but that high rates of hospitalizations suggest quality problems. If these conditions are managed appropriately on an ambulatory basis, the rate of hospitalization should be reduced. PPHs in nursing homes include hospitalizations that result from inadequate assistance with functional disabilities, deficient monitoring and treatment of chronic conditions, and inadequate response to acute conditions that could be addressed within the facility (Walsh et al., 2010).

Most researchers define PPHs based on medical diagnoses. These are diagnoses where good primary care should reduce some, but not all, related hospitalizations. The diagnoses included in lists of potentially preventable conditions vary. The Agency for Healthcare Research and Quality (AHRQ) identifies a list of ACS conditions for the general population (http://archive.ahrq.gov/data/safetynet/billappb.htm), which may not necessarily apply to the older adults in NHs. Table 1 contrasts the medical conditions that have been used to investigate PPHs among NH residents in previous studies or reports.

There are variations across sources; no diagnosis is universally used. The most frequent conditions are angina, asthma, cellulitis, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), dehydration, diabetes, gastroenteritis, hypertension, hypoglycemia, urinary tract infection, and pneumonia. The list of conditions used by Walsh et al. (2010) was specific to nursing home and was also used in the current study. The detailed list of conditions and related ICD-9 codes are described later and in the Appendix A.

1.1.1 Rates of PPH among NH residents

The range of PPH rates among nursing home residents varies widely depending on the definition of conditions used to define PPHs and different methodologies (such as medical claims data or expert review the medical record). Among Medicaid NH residents in Massachusetts, 20% of hospitalizations were identified as high discretionary admissions (M.W. Carter, 2003b). Intrator and colleagues (2004) found that 37% of long-stay NH residents during a six-month period were hospitalized at least once for a primary condition that was potentially preventable. Walsh and colleagues (2010) found that 39% of hospitalizations among dually eligible beneficiaries in a long-term care or skilled nursing facility setting were potentially avoidable. Among long-stay NH residents in the state of New York, 31.3% of hospitalizations were categorized as PPHs over the period 1999 through 2004 (Grabowski, O'Malley, & Barhydt, 2007). Some 55% of hospitalizations from Canadian long-term care were identified as PPHs (Walker, Teare, Hogan, Lewis, & Maxwell, 2009). Using a structured implicit record review, trained physicians rated 45% of residents transferred from nursing facility to the hospital was inappropriate among eight southern California nursing homes (Saliba et al., 2000). In a

Georgia study including long- and short-stay NH residents, 67% of the 200 hospitalizations were rated by long-term care clinicians as potentially avoidable (Ouslander et al., 2010).

1.1.2 Costs of PPH among NH residents

Among all hospitalizations of 1,571,920 dually eligible Medicare and Medicaid beneficiaries in 2005, there were 382,846 PPHs and the cost of PPHs was about $3.1 billion. Of the total hospitalizations included, 72% were from nursing homes, accounting for 85% of the total costs of PPHs (Ouslander & Berenson, 2011). Among long-stay residents in 2004, $223.8 million was spent on PPHs, which accounted for 23% of total spending on hospitalizations in the state of New York (Grabowski et al., 2007). These costs were a conservative estimate because short-stay residents, who had a higher hospitalization rate compared with long-stay residents, were excluded from this study. In a study conducted in 59 nursing homes between 1992 and 1997 in the state of Maryland found that when infection cases resulting in hospitalizations were compared with matched cases managed in the nursing homes, the mean Medicare payments for NH managed cases were $996, compared to $ 5,202 for hospital cases. (Boockvar, Gruber-Baldini, Stuart, Zimmerman, & Magaziner, 2008). A study in the state of Georgia found that the average diagnosis-related group (DRG) payment for PPH was $6, 572 among NH residents (Ouslander et al., 2010). Using this average payment, researchers estimated the cost to Medicare in 2006 for hospitalizations among NH residents would be approximately $142 million and assuming one-third was PPH, the potential saving to Medicare would be approximately $47 million (Ouslander et al., 2010).

1.2 Quality of Care

There are several definitions of quality. The Institute of Medicine (IOM) (1996) defined quality as: "The degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge"(p. 5.). Because the definition is subjective and general, it is very challenging to operationalize. The dominant framework in quality assessment includes structure, process, and outcome (Donabedian, 1966). Structure refers to organizational attributes that provide the opportunity for residents to receive care. Process refers to what is actually done when care is delivered or received. Outcome refers to the effect of care on residents. In theory better structure should facilitate more appropriate processes and better processes should produce better outcomes (Kane, 1998). However, the theoretical linkages are not always supported in the literature (Castle & Ferguson, 2010; Gustafson, Sainfort, Van Konigsveld, & Zimmerman, 1990).

Most of the attention around quality in NHs has been directed at quality of care. Nursing home quality indicators (QIs) and survey deficiencies are widely used to measure quality of care.

1.2.1 Quality Indicators

Quality indicators are used to quantify quality of care and to more effectively monitor the care provided in NHs (Zimmerman, 2003). With its standardized collection and reporting of data on nursing home residents, the Minimum Data Set (MDS) facilitates the development of a set of NH quality indicators. A complete MDS assessment is performed by facility staff at admission, quarterly, annually and whenever the resident experiences a significant change in status. The reference period for many MDS items is either 7, 14, or 30 days prior to the assessment. Assessments based on a subset of data are collected

typically every 3 months. Initially a set of twenty-four QIs were developed by a team of researchers (Zimmerman, 2003). With the implementation of the revised MDS 3.0, the QIs were updated correspondingly. Currently, 18 QIs relevant to long-term care and post-acute residents have been incorporated into Medicare's Nursing Home Compare public reporting system for every Medicare and Medicaid-certified nursing home in the nation. In a parallel effort the Minnesota Department of Human Services created the Minnesota Nursing Home Report Card (http://nhreportcard.dhs.mn.gov/), which uses 26 risk-adjusted QIs to compare performance among all Medicare or Medicaid certified nursing facilities in Minnesota.

All QIs are measured at the resident level from the MDS according to receipt or nonreceipt of a specific service; presence or absence of a condition at a single point in time (prevalence); or development of or change in a condition over time (incidence). A resident-level QI is then aggregated to the facility level and defined as the percent of residents with a given QI condition. A QI may capture a process or outcome of care. For example, "prevalence of indwelling catheters" is a process QI, while "prevalence of urinary tract infections" is an outcome QI. Table 2 shows the name, description, a process or outcome indicator for each QI, and conceptual 10 QI domains from face validity and expert opinion. Some QIs are positively framed measures while others are negative. For example, the QI "incidence of improved or maintained activity of daily living (ADL) independence" is a positive measure, while the QI "incidence of worsening or serious ADL dependence" is a negative one.

1.2.2 Survey deficiencies

To participate in Medicare and Medicaid, nursing facilities must be surveyed by state agencies every nine to 15 months. When a nursing home fails to meet one or more of the federal requirements, surveyors cite a deficiency. There are 190 possible deficiencies. Surveyors also decide the scope and severity of the deficiency based on a matrix that uses the letters "A" through "L". The scope of the deficiency measures the number of residents potentially or actually affected by the deficiency. The scope rating has three different levels: isolated, pattern, and widespread (Table 3). A categorical summary rating based on survey deficiencies was used in the current study as a control variable.

1.3 The Relationship between NH QOC and Hospitalization/PPH

There is great variation in rates of PPH across nursing homes. By state across all settings, the highest rate of PPH (591 per 1, 000 person years) in Louisiana was almost fourfold higher than the lowest rate of PPH (158 per 1, 000 person years) in Hawaii (Walsh et al., 2010). Resident heterogeneity alone did not account for these wide variations in PPH rate (M.W. Carter & Porell, 2003; Walsh et al., 2010). Few studies have investigated the relationship between nursing home QOC and hospitalization or PPH. Using 1991 to 1993 Medicaid data in Massachusetts, a study found no association between annual number of care-related deficiency citations received by a facility and risk of PPH (M.W. Carter, 2003a). Rather, a negative association between deficiency and hospitalization was deemed "an unexpected and troubling finding" (M.W. Carter, 2003a). Using 2003 to 2006 Medicaid data in Florida, a study found that a lack of association between QOC deficiencies and time to first PPH (Becker, Boaz, Andel, Gum, & Papadopoulos, 2010). A study used 1998 to 2004 Minimum Data Set state data in New York to show that facility-level deficiencies were associated with a decreased time to first hospitalization or

the time between subsequent hospitalizations (O'Malley, Caudry, & Grabowski, 2011). A recent study using national Medicare data on fee-for-service Medicare beneficiaries discharged to a skilled nursing facility after an acute care hospitalization between 2009 and 2010, indicated that quality deficiency rating (5 star vs. 1 star; the higher star means less deficiencies) and the proportion of post-acute care residents with new or worsening pressure ulcers (25th percentile vs. 75th percentile) were negatively associated with 30 days hospital readmission and death, respectively (Neuman, Wirtalla, & Werner, 2014). However, the difference was very small, and there was no association between post-acute care residents with moderate to severe pain (25th percentile vs. 75th percentile) and the 30 days hospital readmission and death (Neuman et al., 2014).

However, there are limitations in the above studies investigating the relationship between QOC and hospitalization or PPH. There were different deficiency calculations including: total number of deficiencies (M.W. Carter, 2003a; O'Malley et al., 2011), having a deficiency vs. no deficiency (Becker et al., 2010), or a categorical summary rating based on deficiencies ranged from 1 to 5 stars (Neuman et al., 2014). One study looked at only three quality indicators (QIs): post-acute care residents with new or worsening pressure ulcers, post-acute care residents with delirium, and post-acute care residents with moderate to severe pain (Neuman et al., 2014). Moreover, the studies investigated different aspects of outcomes: hospitalization/PPH (M.W. Carter, 2003a), time to first PPH (Becker et al., 2010), time to first hospitalization or the time between subsequent hospitalizations (O'Malley et al., 2011), 30 days hospital readmission/death (Neuman et al., 2014). The results are not comparable and consistent in these studies. Due to these limitations in the literature, it is unclear whether performance on QIs is related with

differences in quality performance that could predict the likelihood of hospitalization, especially PPH.

1.4 Other Factors Influencing Rates of Hospitalization and/or PPH

1.4.1 Resident characteristics

1.4.1.1 Age

In general, there is a positive association between age and hospitalization in NH residents (Mary W Carter & Porell, 2006; Freiman & Murtaugh, 1993).

1.4.1.2 Gender

Male NH residents are more likely to be hospitalized than female residents (Barker et al., 1994; M.W. Carter, 2003a; Freiman & Murtaugh, 1993; Mor, Papandonatos, & Miller, 2005). However, Carter (2003a) found that when male residents were hospitalized, the cause was less likely to be ACS conditions.

1.4.1.3 Race or ethnicity

The risk of ACS hospitalization was about 35% higher among non-White residents (Becker et al., 2010). This was consistent with another study. Walsh et al (2010) suggested that non-White dually eligible beneficiaries had higher rates of PPHs compared to Whites, and Hispanic residents also had higher rates.

1.4.1.4 Length of NH stay

Hospitalizations were high for new admitted residents and then decreased with length of stay (Mary W Carter & Porell, 2006; Freiman & Murtaugh, 1993).

1.4.1.5 Health status

NH residents with medical conditions more likely to exacerbate had increased risk of hospitalization, while resident medical conditions with comparatively little expected

acceleration of degenerative decline were associated with decreased relative risk of hospitalization (Mary W Carter & Porell, 2006). More physically disabled NH residents were more likely to be hospitalized (Freiman & Murtaugh, 1993). Dementia and serious mental disorders were related to higher risk of ACS hospitalization (Becker et al., 2010).

1.4.1.6 Advance care planning

Advance directives include do-not-hospitalize (DNH), do-not-resuscitate (DNR), and do-not-intubate (DNI) orders. A survey of medical directors and directors of nursing in NHs found that they both rank preference as the most important determinant in the decision to hospitalize (Buchanan et al., 2006). Residents with advance care planning documents were associated with fewer hospitalizations than those without these documents (Dobalian, 2004). NH residents who participated in hospice care were less likely to be hospitalized in the last 30 days of life than those dying without hospice care (Gozalo & Miller, 2007).

1.4.2 Nursing home characteristics

1.4.2.1 Ownership

One study found that not-for-profit NHs had a lower hospitalization rate compared with for-profit NHs (Murtaugh & Freiman, 1995). For-profit skilled nursing facilities had the highest risk of hospital readmission or death within 30 days of hospital discharge compared with not-for-profit and government facilities, however, the difference was small (Neuman et al., 2014). One study found that for-profit facilities had greater risk of PPH compared with not-for-profit facilities (Becker et al., 2010). The hospitalization rates at government-owned facilities were higher than at for-profit facilities, while the rates at nonprofit and for-profit facilities were similar (O'Malley et al., 2011).

1.4.2.2 Chain membership

There is no significant difference on the risk of hospital readmission or death within 30 days of hospital discharge for skilled nursing facility residents on the chain membership (Neuman et al., 2014). One study found that facilities that were not a member of a chain had greater risk of PPH (Becker et al., 2010).

1.4.2.3 Staffing

The availability and skill level of staff play an important role in reducing hospitalizations. One review found a consistent positive relationship between higher registered nurse (RN) staffing and better outcomes, including reduced hospitalization rate (Konetzka, Spector, & Limcangco, 2008). More RN staffing significantly reduced the likelihood of pressure sores and urinary tract infection associated with PPH, whereas increasing other staffing did not have the same effect (Konetzka, Stearns, & Park, 2008). Nursing staff comprised of more highly trained RNs versus more licensed practical nurses (LPNs) were at lower risk of hospitalization among NH residents (M.W. Carter & Porell, 2003). LPNs have limited ability to identify medical symptoms, manage complicated care plans, and take effective interventions. An increase in average RN direct care time of 30 or 40 minutes per resident per day was related to lower hospitalizations (Dorr, Horn, & Smout, 2005). Nursing facilities with on-staff nurse practitioners or physician assistants (NP/PAs) were associated with fewer ACS hospitalizations, while nursing facilities with more on-staff physicians were associated with more ACS hospitalizations (Intrator et al., 2004). Facilities with a higher RN-to-nurse ratio had lower odds of ACS hospitalization, while facilities with a higher certified nurse assistant (CNA) to nurse ratio had higher odds of ACS hospitalizations (Intrator et al., 2004).

1.4.2.4 NH infrastructure

Providing care to acutely ill NH residents in lieu of a hospitalization requires frequent clinical assessment, timely laboratory tests and X-rays, and, often, intravenous therapy. Intrator et al. (2004) found that nursing facilities with intravenous therapy capacity had fewer ACS hospitalizations and non-ACS hospitalizations; however, the availability of on-site laboratory tests or X-ray services had no relationship with ACS hospitalizations.

1.4.2.5 Other NH characteristics

One study found that facilities with fewer than 120 beds had greater risk of PPH and there was no PPH difference on occupancy rate (above 95% vs. below 95%) (Becker et al., 2010). Skilled nursing facilities with lower occupancy rate (25^{th} vs. 75^{th} percentile), and more than 50 beds had higher risk of hospital readmission or death within 30 days of hospital discharge for residents (Neuman et al., 2014). There is no significant difference on the risk of hospital readmission or death within 30 days of hospital discharge for skilled nursing facility residents on hospital based or not (Neuman et al., 2014).

2 Study Aims

It is unclear whether performance on QIs is related to differences in quality performance that could predict the likelihood of hospitalization, especially PPH. This study investigates: 1) the relationship between QIs and hospitalization; 2) the relationship between QIs and PPH.

2.1 Latent Construct

Quality indicators and hospitalizations/PPH may not be related to each other by a direct causal path (Figure 1). Rather, there is a common latent construct, quality, for QIs and hospitalization/PPH. There are four potential ways to reduce PPHs in nursing homes: better primary care to prevent adverse events, better management before a crisis ensues, managing events well on site, and electing not to transfer end-of-life residents to hospital. There are also many latent factors affecting performance on quality indicators, such as leadership, structure of organizations, organizational culture, adherence to protocols (procedures, standards, and rules), staffing (knowledge, skills, and experience) sufficiency and stability, workload, teamwork, and effective communication etc. These latent factors could also affect the potential pathways related to hospitalization/PPH.

We start with an assumption that quality indicators are proxies for nursing home quality. Performance on QIs captures the differences in certain aspects of quality, which is related to variation in rates of hospitalization or PPH. The assumption is that nursing facilities with better performance on quality indicators, which reflects these facilities providing better care, would potentially be associated with reduced PPH. For example, some quality indicators, such as the percent of self-reported moderate to severe pain for short- and long-stay residents, or prevalence of unexplained weight loss for long-stay residents, are

not directly associated with medical conditions used to define PPH. However, if nursing facilities have a low percent/ prevalence of pain or weight loss, we assume that they do a good job on monitoring residents at risk carefully and regularly, and identifying the signs for exacerbations early. So the PPH conditions, such as congestive heart failure or dehydration, will not become severe enough to require hospitalizations.

2.2 Conceptual model

Figure 2 presents a conceptual model of how quality indicators may be related to hospitalizations/PPHs. Although we use a direct line to show the relationship between quality indicators and hospitalizations/PPHs, the relationship is not a direct causality as mentioned above. NH residents have different levels on cognitive impairment, ADL limitations, and comorbidities, which could affect the rate of hospitalization/PPH. Other resident characteristics such as age, race, and gender may also affect PPH. We need to adjust for them in the analysis to isolate the association of quality indicators with PPH. Staffing has a relationship with PPH. The effect of staffing on the rate of PPH may be confounded with its role in quality indicators. For example, higher RN staffing may be associated with improvement in quality indicators about incontinence, and with reduced rate of PPH due to urinary tract infections. Also, some effect of staffing may not be reflected on QIs, but on the rate of PPH. Ownership may have a direct relationship with PPH and may influence PPH through QOC. These nursing home characteristics are also need to be adjusted in the analysis.

2.3 Specific PPH

Certain QIs have direct relationships with specific medical conditions used to define PPH, such as falls and trauma, urinary tract infections, and pneumonia. Table 4 shows

some hypothesized explicit relationships between selected QIs and PPH diagnoses. For example, the several quality indicators around incontinence for long-stay residents (such as, incidence of worsening bladder incontinence, prevalence of indwelling catheter, or prevalence of urinary tract infection) are directly related to urinary tract infection, which is one of the medical conditions to define PPH. Nursing facilities with low incidence/prevalence of these incontinence indicators, which indicate good quality of care, are more likely to have low rate of PPH due to urinary tract infection.

3 Methods

3.1 Data

This study was approved by the University of Minnesota Institutional Review Board, which waived the requirement for participant informed consent. Data sources included the nursing home Minimum Data Set, which includes detailed clinical data on all residents in Medicare or Medicaid certified nursing homes; the Minnesota Nursing Home Report Card file, which compiles data on nursing home characteristics and quality performance; and the Medicaid claims data files, which include records of inpatient care for the Medicaid beneficiaries over the 2011-2012 time periods. All data files were recoded with unique internal linking variables so that all statistical analyses were conducted with de-identified datasets.

The MDS assessment is performed by facility staff at admission, quarterly, annually and whenever the resident experiences a significant change in status. This comprehensive assessment includes many items such as: diagnoses; the ability to do activities of daily living; clinical conditions such as the presence of sores, wounds or cuts on the body; use of certain types of medications; dehydration; mental functioning; and certain elements of care and treatment provided to the resident. An updated version of the assessment form, the MDS version 3.0, was introduced on October 1, 2010. The following sections: identification information, hearing, speech and vison, cognitive pattern, mood, behavior, functional status, bladder and bowel, active diagnoses, health conditions, and special treatments were used in the current study.

The Minnesota Nursing Home Report Card compares nursing facilities on the seven quality measures: quality indicators, resident satisfaction and quality of life, hours of

direct care, staff retention, use of temporary nursing staff, proportion of beds in single bedrooms, and state inspection results. In this study, we used the following elements: risk-adjusted MDS quality indicators, hours of direct care, staff retention, use of temporary nursing staff, proportion of beds in single bedrooms, and state inspection results. Selected items from the MDS have been identified as potential indicators of the quality of care provided to the resident. The report card uses 26 quality indicators to calculate the QI score.

3.2 Study population

The study population included Medicaid beneficiaries aged 65 years and older who lived in a NH in Minnesota between January 1, 2011, and December 31, 2012.

3.3 Outcomes

3.3.1Hospitalization

The primary outcome was a composite end point of hospitalization or death from any cause in each quarter during 2011-2012. To prevent inappropriate censoring of observations, death was included in the primary outcome. A secondary analysis using an end point of only hospitalization was conducted for comparison.

3.3.2 Potentially preventable hospitalization

The primary outcome was an end point of potentially preventable hospitalization defined by a list of Ambulatory Care Sensitive conditions in each quarter during 2011-2012 periods. PPH was identified using the same logic and diagnosis codes described by Walsh (2010). The algorithm was developed by an expert panel and specific for NHs. The 16 conditions which were used to identify PPH were COPD/asthma, congestive heart failure, constipation, dehydration, hypertension, poor glycemic control, seizures, urinary tract

infection, weight loss/malnutrition, altered mental status, anemia, diarrhea, falls/trauma, pneumonia, psychosis/agitation, and skin ulcers. The detailed ICD-9 diagnosis codes to define PPH are in Appendix A.

3.4 Independent variables

The 26 indicators of the quality of care provided to the residents are listed in Table 2, from the Minnesota Nursing Home Report Card. The QIs were risk adjusted by the Minnesota Report Card project to account for differences between the types of residents served in NHs. Examples of the adjustors used are: age, gender, cognitive performance (mental functioning), Alzheimer's disease, stroke, and ADL ability. More details regarding the calculation of the QIs are described in the website of Minnesota Department of Human Services.

3.5 Control variables

A categorical summary rating based on deficiencies identified through site inspection surveys conducted by the Minnesota Department of Health ranged from 1 to 5 stars, with one star representing the lowest possible rating and five stars representing the highest possible rating. In the current study, a binary variable (3 or fewer stars vs. 4 or more stars) was used in the analysis. Other NH characteristics included ownership (for-profit, not-for-profit, or government owned), hospital affiliation, location (urban or rural area), chain membership, facility size (total beds), facility acuity (calculated on a Resource Utilization Group (RUG)-days basis, weighted by the Minnesota case mix values for each RUG and it represented the mean daily acuity for the facility over the reporting period), the percentage of resident days covered by Medicare, Medicaid, and paid privately within each facility, proportion of single bed rooms, and staffing variables (direct care staff

hours per resident day, direct care staff retention rate, and the percentage of temporary/pool hours versus total staff hours).

We obtained additional data on potential confounders from the MDS, including resident age, gender, race, marital status, cognitive impairment, end of life (life expectancy of less than 6 months), hospice care, mood score, length of stay in NH (≤ 30 days, ≤ 90days, or >90 days), admission sources to NH (hospital, community, other places), and the following conditions: acute onset mental status change, psychosis, anemia, heart failure, hypertension, diabetes, hip fracture, Alzheimer's disease, cerebrovascular accident, transient ischemic attack or stroke, non-Alzheimer's dementia, hemiplegia or hemiparesis, Parkinson's disease, seizure disorder or epilepsy, anxiety, manic depression, asthma, COPD or chronic lung disease, respiratory failure, delirium.

3.6 Statistical analysis

The facility-level QIs were assessed in each quarter and could change during the two-year period. The residents' health status could also change over time. To account for these time-varied variables, the analyses were conducted at the resident-quarter level. The resident-level variables closest to the beginning of each quarter were used in the analysis. The outcomes of interest were: (1) the number of hospitalizations and death in each quarter; (2) the number of hospitalizations in each quarter; and (3) the number of PPHs in each quarter. To account for nested structure of residents in NHs, the Generalized Linear Mixed Model (GLMM) was used for analysis. We used the xtpoisson procedure available in Stata version 12.1, which takes into account the exposure time. For the models, the exponentiated coefficients are interpreted as incidence-rate ratios (IRRs). We conducted a base model containing only 23 risk-adjusted variables, a model controlled only NH

characteristics, a model controlled only resident characteristics, and a fully specified model with all control variables. For those residents lived in more than one NH over this 2-year period, they were treated as independent residents in different NHs. We also tested some hypothesized explicit relationships between certain QIs and specific medical conditions used to define PPH, such as urinary tract infections, falls and trauma, and pneumonia (Table 4).

The GLMM specifies that

$$- \quad \ln\left\{\frac{E(Y_{ij})}{ExposureTime_{ij}}\right\} = QOC_j\beta_{QOC,j} + X_j\beta_j + X_{ij}\beta_{ij} + \mu_j$$

Where

$$- \quad Y_{ij} \sim Poisson$$

$$- \quad \mu_j \sim N(0, \sigma_\mu{}^2)$$

- Y_{ij} = outcome variable of interest, that is the number of hospitalizations and death, hospitalizations, or PPHs in each quarter. The subscript i refer to the resident; j refers to the nursing home.
- $ExposureTime_{ij}$ = the number of residence days in each quarter.
- QOC_j = a vector of NH quality of care variables in each quarter, including quality indicators and one binary quality deficiency variable.
- X_j = a vector of other nursing home characteristics.
- X_{ij} = a vector of resident characteristics, including health status variables.
- μ_j = a NH-specific component of the error term.

4 Results

4.1 Descriptive results

The study included 368 nursing homes licensed in Minnesota and certified to participate in Medicaid during 2011-2012. As shown in Table 5, 27 percent were for-profit facilities, 61 percent were not-for-profit facilities, and 11 percent were government-owned facilities. Nearly 15 percent of nursing homes were hospital-based. Almost half of the nursing homes (47%) were located in the urban area and more than half NHs (52%) had chain membership. The average number of total beds was 83 with median 68. Approximately 43 percent of beds were in private rooms. On average, NHs provided more than 5 hours of direct care staff per resident day. About 73 percent of direct care staff were retained for the entire reporting year. Less than one percent of direct care staff hours were provided by temporary/pool workers. About 56 percent of all resident days were covered by Medicaid, 9 percent covered by Medicare, 27 percent paid privately, and the rest covered by other insurance. For the five-star facility inspection rating, about one third of NHs were rated as 5 stars, one third of NHs were rated 4 stars and the other one third were rated as 3 stars and below.

Some 24,530 Medicaid beneficiaries aged 65 years lived in one of the NHs in Minnesota over the 2011-2012. As shown in Table 6, most residents were admitted to only one NH. Approximately 9 percent residents lived in more than one NH. For those residents in more than one NH, only the information when the resident first appeared in one of the NHs was used. The mean age was approximately 84 years of age and roughly 73 percent of older adults were women. The majority residents were non-Hispanic White and unmarried (widowed, separated, divorced, or never married). Nearly 72 percent were

long-stay residents (> 90 days). More than half (53 percent) residents needed extensive assistance for ADL and 22 percent were total dependence. About one third of residents had mild, moderate, or severe depression over the last two weeks. Twenty-six percent residents had moderate cognitive impairment and 31 percent had severe cognitive impairment. Nearly half residents (47 percent) had pain or hurting at any time in the last 5 days. Five percent residents had a condition or chronic disease that may result in a life expectancy of less than 6 months. Nearly 6 percent received hospice care. The ten most prevalence diagnoses among residents were hypertension, urinary incontinence, depression, dementia, bowel incontinence, diabetes mellitus, anemia, heart failure, anxiety disorder, asthma, COPD, or chronic lung disease.

The average hospitalization rate for NHs was approximately 302 per 1, 000 person years. The average PPH rate for NHs was approximately 134 per 1, 000 person years. Approximately 44 percent of hospitalizations were PPHs. About one-third of residents (32.97%) died during the two-year period. Among all Medicaid residents, about 19 percent were hospitalized. Among hospitalized residents, 76 percent had one hospitalization; 15 percent had two hospitalizations; 5 percent had three hospitalizations; and 4 percent had four and more hospitalizations. As shown in Table 7, the most common primary diagnoses for hospitalization were diseases of the respiratory system and circulatory system, which accounted for nearly 40 percent of hospitalizations. As shown in Table 8, the most common conditions associated with PPH were pneumonia and bronchitis (33%), congestive heart failure (14%), falls and trauma (13%), and urinary tract infection (12%).

Table 9 shows the distribution of QIs. The average incidence of walking as well or better than previous assessment was about 77 percent. The average incidence of worsening or serious ADL dependence was about 17 percent. The average prevalence of antipsychotics without a diagnosis of psychosis was about 12 percent. The average prevalence of physical restraints was only about 1 percent. The average prevalence of falls with major injury was about 4 percent.

The average incidence of walking as well or better than previous assessment was very high because the QI's trigger included residents who could walk before and still walk at assessment and excluded residents who did not walk at all. The average values of 2 QIs about prevalence of occasional to full incontinence without a toileting plan were also high because the QI denominator excluded residents who were continent. For the 2 QIs about incidence of improved or maintained continence, these 2 QIs' trigger included residents who were continent and remained continent, so the values tended to be higher. There are many missing data for 3 QIs; two dealt with pressure sores, which are rare. The "incidence of healed pressure sores" was missing for 88.7% of NHs. The "prevalence of new or worsening pressure sores", which was used for short-stay residents, was missing for 34.7% of NHs. The "incidence of decrease in pain when admitted on a pain medication regimen" was also used with short-stay residents and was missing for 49.6% of NHs. These QIs excluded a lot of cases. The "incidence of healed pressure sores" had a highly restrictive denominator and facilities with no pressure sores would show no information for this measure. For the 2 short-stay QIs, a fair number of facilities fell below the minimum number to report a QI, since only facilities with a significant short-stay business and a sufficient bed count would generate enough cases. For "incidence of

decrease in pain", it only included short-stay residents with both an admission and a discharge assessment in the target quarter and with pain items reported on both assessments, who were receiving pain medication at admission. Therefore, these 3 QIs were dropped in the final analysis.

4.2 The relationship between NH QOC and hospitalization /death

Among 23 risk-adjusted QIs, only 6 QIs were associated with the risk of hospitalization/death in the fully adjusted model. Table 10 summarizes several variations of the multivariate analysis of the relationship between the QIs and the composite outcome hospitalization or death. Each column reflects a different level of adjustment. Five QIs ("incidence of worsening or serious ADL dependence", "incidence of improved or maintained ADL independence", "prevalence of unexplained weight loss", "prevalence of antipsychotics without a diagnosis of psychosis", and "incidence of improved or maintained bladder continence") show a consistently significant relationship with the outcome across all variations of adjustment. Two QIs ("incidence of walking as well or better than previous assessment" and "prevalence of residents who report moderate to severe pain (short stay)") are significant until the fully adjusted model. One QI "prevalence of pressure sores in high-risk residents" is non-significant until the full model and the model adjusted for resident-level variables. The other 15 QIs show a consistently non-significant relationship with the outcome across all variations of adjustment.

In the following, the relationship between QIs and the composite outcome hospitalization/death in the fully adjusted model were described in each domain.

4.2.1 Physical Functioning (6 QIs)

The QI "incidence of worsening or serious ADL dependence" was significantly related to higher rates of hospitalization/death (IRR=2.317, P<0.001). Conversely, the QI "incidence of improved or maintained ADL independence" was significantly related to lower rates of hospitalization/death (IRR=0.658, P<0.05). These 2 QIs measured the opposite aspects of ADLs and were consistent in regard to the risk of hospitalization/death.

The other 3 QIs assessing physical functioning: incidence of walking as well or better than previous assessment, incidence of worsening or serious mobility dependence (moving in and around the room), and incidence of worsening or serious range of motion limitation (ability to move the joints of the upper or lower extremities), were not significantly associated with the rates of hospitalization/death. The directions of effect size were as expected for QIs "incidence of walking as well or better than previous assessment" (IRR=0.799, P>0.05) and "incidence of worsening or serious mobility dependence" (IRR=1.179, P>0.05).

Another QI related to physical functioning: "prevalence of falls with major injury" measured the percent of long-stay residents who had experienced one or more falls with major injury (e.g. bone fractures, joint dislocations). This QI increased the risk of hospitalization/death, but not significantly (IRR=1.263, P>0.05).

4.2.2 Nutrition and Skin Care (2 QIs)

Both QIs "prevalence of unexplained weight loss" and "prevalence of pressure sores in high-risk residents" were significantly associated with higher rates of hospitalization/death (IRR=4.461, P<0.001; IRR=3.486, P<0.05, respectively).

4.2.3 Psychosocial Care and Psychotropic Medications (4 QIs)

The QI “prevalence of antipsychotics without a diagnosis of psychosis” was significantly related to lower rates of hospitalization/death (IRR=0.616, P<0.05). The result was unexpected. Because this QI indicated bad performance, it should have a positive association with the risk of hospitalization/death. By contrast, the QI “prevalence of physical restraints” was not significantly related to higher rates of hospitalization/death (IRR=1.295, P>0.05).

The QI “incidence of worsening or serious resident behavior problems” was associated with lower rates of hospitalization/death, but not significantly (IRR=0.715, P>0.05). The QI “prevalence of depressive symptoms” had no significant association with the risk of hospitalization/death (IRR=0.620, P>0.05).

4.2.4 Infections (2QIs)

The QIs “prevalence of urinary tract infections” and “prevalence of infections” were associated with higher but non-significant risk of hospitalization/death (IRR=2.009, P>0.05; IRR=1.075, P>0.05; respectively).

4.2.5 Continence Care (7 QIs)

The QI “incidence of improved or maintained bladder continence” had a significant association with higher risk of hospitalization/death (IRR=1.466, P<0.05). This too was unexpected. The QI “prevalence of indwelling catheters” had a non-significant association with higher rates of hospitalization/death (IRR=1.109, P>0.05).

The other 5 continence QIs “incidence of improved or maintained bowel continence”, “incidence of worsening or serious bladder incontinence”, “incidence of worsening or serious bowel incontinence”, “prevalence of occasional to full bladder incontinence without a toileting plan”, and “prevalence of occasional to full bowel incontinence

without a toileting plan" were not significantly associated with the risk of hospitalization/death .

4.2.6 Pain (2 QIs)

The QI "prevalence of residents who report moderate to severe pain" for both short-stay and long-stay residents was not significantly associated with the risk of hospitalization/death.

4.3 The relationship between NH QOC and Hospitalization

Table 11 summarizes several variations of the multivariate analysis of the relationship between the QIs and hospitalization wherein death is de facto combined with not being hospitalized. As with Table 10, each column reflects a different level of adjustment. Three QIs ("prevalence of unexplained weight loss", "prevalence of antipsychotics without a diagnosis of psychosis", and "incidence of improved or maintained bladder continence") show a consistently significant relationship with the outcome across all variations of adjustment. Two QIs ("incidence of walking as well or better than previous assessment" and "prevalence of urinary tract infections") are significant in the previous model but non-significant in the fully adjusted model. Two QIs ("incidence of worsening or serious ADL dependence" and "prevalence of pressure sores in high-risk residents") are non-significant until the full model and the model adjusted for resident-level variables. The other 16 QIs show a consistently non-significant relationship with the outcome across all variations of adjustment.

Among 23 risk-adjusted QIs, only 5 QIs were associated with the risk of hospitalization in the fully adjusted model. When the outcome of interest was hospitalization, rather than the composite end of hospitalization or death, the significance of QIs remained the same

except the QI “incidence of improved or maintained ADL independence”. The QI “incidence of improved or maintained ADL independence” had no significant relationship with the lower rate of hospitalization.

4.4 The relationship between NH QOC and PPH

Table 12 summarizes several variations of the multivariate analysis of the relationship between the QIs and PPH. Again, each column reflects a different level of adjustment. Three QIs (“prevalence of unexplained weight loss”, “prevalence of antipsychotics without a diagnosis of psychosis” and “prevalence of urinary tract infections”) show a consistently significant relationship with PPH across all variations of adjustment. One QI “prevalence of residents who report moderate to severe pain (long stay)” is significant with PPH until the fully adjusted model. One QI “incidence of improved or maintained ADL independence” is consistently significant with PPH in all models except the model adjusted only for NH level variables. The other 18 QIs show a consistently non-significant relationship with PPH across all variations of adjustment.

Among the 23 risk-adjusted QIs, only 4 QIs were associated with the risk of PPH in the fully adjusted model. The QIs “prevalence of unexplained weight loss” and “prevalence of urinary tract infections” were significantly associated with the higher rates of PPH (IRR=8.219, $P<0.05$; IRR=5.733, $P<0.05$; respectively). The QI “incidence of improved or maintained ADL independence” was significantly associated with the lower rates of PPH (IRR=0.393, $P<0.05$). The QI “prevalence of antipsychotics without a diagnosis of psychosis” was ironically significantly associated with the lower rates of PPH (IRR=0.310, $P<0.05$).

4.5 The relationship between NH certain QIs and specific PPH diagnoses

The relationships between NH certain QIs and specific PPH diagnoses were tested. The limited number of hospitalizations with primary diagnosis “psychosis, severe agitation, and organic brain syndrome” (27) and “weight loss and nutritional deficiencies” (4) precluded examining the relationships between these QIs and specific PPH diagnoses.

4.5.1 Pneumonia and bronchitis

The QI “prevalence of infections” shows a consistently significant positive relationship with hospitalizations with primary diagnosis pneumonia and bronchitis across all variations of adjustment (Table 13).

4.5.2 Falls and trauma

The two QIs “incidence of worsening or serious ADL dependence” and “prevalence of falls with major injury” show a consistently significant positive relationship with hospitalizations with primary diagnosis falls and trauma across all variations of adjustment (Table 14).

4.5.3 Urinary tract infection

The two QIs “prevalence of urinary tract infections” and “prevalence of indwelling catheters” show a consistently significant positive relationship with hospitalizations with primary diagnosis urinary tract infection across all variations of adjustment (Table 15).

4.5.4 Skin ulcers and cellulitis

The QI “prevalence of pressure sores in high-risk residents” shows a consistent but non-significant relationship with hospitalizations with primary diagnosis skin ulcers and cellulitis across all variations of adjustment.

In summary, available quality indicators were not strongly or consistently associated with differences in the risk of hospitalization or PPH (Table 17). Among 23 risk-adjusted QIs,

only 6 QIs were associated with hospitalization/death; only 5 QIs were associated with hospitalization; and only 4 QIs were associated with PPH in the fully adjusted model. In these significant QIs, “prevalence of unexplained weight loss” was significantly related to an increased risk of any of the three outcomes and “prevalence of antipsychotics without a diagnosis of psychosis” was significantly associated with a decreased the risk of any of the three outcomes. Sixteen QIs showed no significant association with any of the three outcomes in the fully adjusted models. Although certain QIs had direct relationships with specific PPH diagnoses, such as urinary tract infection, falls and trauma, and pneumonia, most QIs did not adequately capture the aspects of quality that directly related to hospitalization or PPH.

5 Discussion

Among Medicaid beneficiaries aged 65 years and older who received care in a Minnesota nursing home during 2011-2012, better performance on most of the available 23 risk-adjusted quality indicators was not strongly or consistently associated with a lower adjusted risk of hospitalization or death or PPH. Although better performance on 3 QIs (incidence of walking as well or better than previous assessment, prevalence of moderate to severe pain, prevalence of urinary tract infections) was associated with a lower risk of hospitalization or death in unadjusted analyses, these associations were attenuated substantially after adjustments for facility level and other resident level variables. For the outcome hospitalization or death, in the fully adjusted regression model, nursing facilities with better performance on 4 QIs ("incidence of worsening or serious ADL dependence", "incidence of improved or maintained ADL independence", "prevalence of unexplained weight loss", and "prevalence of pressure sores in high risk residents") demonstrated a lower adjusted risk of hospitalization or death; however, the relationship with hospitalization or death seems counterintuitive in 2 QIs. "Prevalence of antipsychotics without a diagnosis of psychosis" was associated with a lower adjusted risk of hospitalization or death; and "incidence of improved or maintained bladder continence" was associated with a higher adjusted risk of hospitalization or death. Better performance on 3 QIs ("incidence of improved or maintained ADL independence", "prevalence of unexplained weight loss", and "prevalence of urinary tract infections") demonstrated a lower adjusted risk of PPH; however, the adjusted PPH did not vary expectedly across nursing facilities. As above, facilities with poorer performance on the QI "prevalence of antipsychotics without a diagnosis of psychosis" showed lower PPH rates.

The findings of weak relationships between QIs and hospitalization were consistent with the previous research conducted by Neuman et al., although we had a richer set of QI measures and investigated different aspects of outcomes. Neuman et al. examined the relationship between 3 QIs (the percentage of residents with delirium, moderate to severe pain , and new or worsening pressure ulcers) and hospital readmission or death among Medicare beneficiaries receiving postacute care in skilled nursing facilities and found that only the QI "the percentage of postacute care residents with new or worsening pressure ulcers" was related to the risk of readmission to an acute care hospital or death within 30 days of the index hospital discharge (Neuman et al., 2014).

Our findings prompt reconsideration of our initial assumption that quality was a latent factor that included both the type of quality reflected in the QIs and that associated with hospital admission. Our results indicate that most QIs did not adequately capture the aspects of nursing home quality that directly relates to hospitalization or PPH; the care reflected in QIs was not the same as the care reflected in hospital admission. This suggests that rather than assuming one large latent variable for quality, we need to think about separate constructs.

Quality indicators and hospitalization may be related to different pathways. The transition of care generally starts when a resident experiences a status change; the earlier that change is detected and addressed, the greater the opportunity to prevent a hospital admission. Prior to that, good primary care can prevent problems from occurring. According to the American Medical Directors Association (AMDA), an acute change of condition is a clinically important change from a resident's well-established and documented baseline in physical, cognitive, behavioral or functional domains. For

example, an older resident may decrease oral intake over 24 hours. Early identification of changes in resident status allows actions before the problem becomes serious enough to warranty considering transfer. The aid staff needs to proactively communicate these changes to licensed nursing staff who can then take actions to manage the event. The nursing staffs need to know how to evaluate such changes in condition. For example, the nursing staff may assess the resident to find out whether the resident is at risk for dehydration and encourage the resident to take oral fluid on a scheduled frequency. If the situation gets worse and the nurses feel the resident may need more intensive medical attention or even be sent to the emergency department, the medical director or primary care provider needs to be fully informed. The medical staffs need to believe these medical issues can be managed at the facility without hospitalization (including a willingness to make visits to the NH). Also the facility may need the capacity to perform certain medical tests and procedures on-site. For example, if intravenous therapy is available in the facility, the conditions can be managed within the facility. Thus, hospitalization could be reduced through pathways that address medical issues and behaviors issues by better primary care, early recognition, early intervention and treatment in NH.

However, most QIs relate to different aspects of nursing care, such as incontinence care, pain and behavioral management, and only a few QIs relate directly to the hospitalization pathways, such as antipsychotics, urinary tract infections, and pressure ulcers. Even for these QIs, the items they address may not be directly related to primary care and resident management to prevent transfers. In sum, success in QIs largely reflects elements of nursing care that are different from those that involve primary care; moreover, preventing

hospitalizations requires more interaction between nursing and medical care. Nursing can affect both QIs and hospitalizations but the specific nursing activities are likely different. Many of the elements of care measured by the QIs have little to do with reducing hospitalization. Thus, improving performance on these QIs alone would not result in large-scale reductions in hospitalization or PPH.

Moreover, QI performance is not consistent. A nursing facility may excel at some QIs and do poorly on other QIs (Rantz et al., 2004). For example in the first quarter of 2011, our results showed that one facility with the worst performance on the QI "incidence of worsening or serious ADL dependence performed better than 75% facilities on the QIs "incidence of worsening or serious behavioral problems" and "prevalence of urinary tract infections". One facility that performed best on the QI "incidence of worsening or serious ADL dependence" performed worse than 75% of facilities on the QIs "prevalence of moderate to severe pain" and "prevalence of depressive symptoms".

The quality of NH care is inherently multidimensional (Mor, Angelelli, Gifford, Morris, & Moore, 2003; Rantz et al., 2004; Zimmerman, 2003). The QIs do capture some underlying dimensions of problems in quality of NH care. We conducted a factor analysis based on available 16 QIs. The results suggest four main factors or domains that characterize facility performance: continence care, physical functioning, restraints and behavior problems, and care for specific conditions.

The inconsistent performance of QIs and the weak relationship between QIs and hospitalization should not be interpreted as evidence that these QIs are not good measures for assessing quality in nursing facilities. They simply tap unrelated areas of care. Our results do not diminish the value of these quality indicators. Focusing on QIs should

improve NH quality in other important areas. Residents would undoubtedly prefer nursing facilities that were more effective at providing continence care, improving physical functioning, or managing restraints and behaviors problems, depending on their specific needs.

Several care elements related to QIs that were associated with hospitalization/PPH.

5.1 Unexplained weight loss

In the current study, unintentional weight loss occurred in about 6% of long-stay older residents (interquartile range: 4%-8%). The prevalence of unintentional weight loss, as defined by MDS criteria (a weight loss of 5% or more in 30 days or 10% or more in 180 days), has ranged from 6% to 15% (Blaum, Fries, & Fiatarone, 1995; Flacker & Kiely, 2003; Kruse et al., 2010).

Unintentional weight loss is a cardinal feature of frailty reflecting disease progression and is an important prognostic indicator. Numerous studies have suggested that weight loss in older adults is associated with adverse health outcomes, such as pressure ulcer (Horn et al., 2004), decline in ADL function and mobility (Ritchie et al., 2008), hip bone loss and subsequent hip fracture (Ensrud et al., 2003). In a retrospective medical record review, older adults in long-term care facilities who lost at least 5% weight in 1 month were 5-fold more likely to die within 1 year (Ryan, Bryant, Eleazer, Rhodes, & Guest, 1995). Compared to weight stability or weight gain, older NH residents with weight loss of more than 5% in any month had a 10-fold increased risk for death (Sullivan, Johnson, Bopp, & Roberson, 2004). Unintentional weight loss (>5% within 6 months) was an independent predictor for hospitalization among the elder residents in long-term care facilities (L.-K. Chen, Lin, Hwang, Wang, & Chwang, 2007). The current study confirms that prevalence

of unexplained weight loss had a positive association with higher risk of the composite outcome (hospitalization and death), hospitalization, and PPH. Unintentional weight loss may reflect underlying disease which may have an association with hospitalization or death, although in our study we adjusted many known risk factors, including advanced age, depression, dementia, cancer, impaired function, and medical diagnoses. Moreover, facility level prevalence of unintentional weight loss has long been used as a measure of nursing home quality. Our results were similar to a previous study that residents residing in facilities with a higher than expected incidence of unexplained weight loss or gain experienced increased risk of hospitalization (Mary W Carter & Porell, 2006). Our results suggest that high prevalence of unintentional weight loss indicated poor quality of care: how the nursing facilities treated residents for their nutritional or medical problems and whether these facilities responded appropriately for residents' weight changes.

5.2 Inappropriate use of antipsychotics

Antipsychotic drugs are commonly used to manage behavioral and psychological symptoms of dementia in nursing facilities. The off-label use of antipsychotic drugs is often viewed as a form of chemical restraint to sedate and subdue residents. In a population of 16,586 newly admitted NH residents in 2006, more than 29% of residents received at least 1 antipsychotic drug and of these users, 32% had no identified clinical indication for this therapy (Y. Chen et al., 2010). In current study, the average prevalence of antipsychotics without a diagnosis of psychosis was nearly 12% among long-stay Medicaid older residents (interquartile range: 6%-16%).

The use of antipsychotic drugs without the identified clinical indication is considered suboptimal care. The inappropriate use of antipsychotics has resulted in adverse events including mortality with marginal clinical benefits (Chiu, Bero, Hessol, Lexchin, & Harrington, 2015). Since high rates of antipsychotic drug prescribing may signal poor quality of NH care, we would expect the QI "prevalence of antipsychotics without a diagnosis of psychosis" may be associated with higher risk of hospitalization or PPH. However, in current study we found an opposite associations and the associations were robust with or without the adjustment of facility and other resident characteristics. Residents from NHs that had high rates of antipsychotic use experienced reduced risk of hospitalization and PPH.

This paradox may be explained by the clinical role of these chemical restraints. A frequent cause of hospitalizations is residents acting out or violence by residents due to dementia or behavioral health issues (Perry, Cummings, Jacobson, Neuman, & Cubanski, 2010). Thus, even though the practice is considered dangerous, use of antipsychotics may reduce hospitalizations by making residents more tractable. Our findings were similar to previous research that found the number or rate of hospitalizations among users of conventional or atypical antipsychotics was lower than among nonusers (Chan et al., 2011; Raivio, Laurila, Strandberg, Tilvis, & Pitkälä, 2007).

5.3 Physical function (activities of daily living)

The residents' ability to perform basic daily activities is important in maintaining health status and quality of life. Loss of independence in physical function has been recognized as an indicator of general decline and hence may be an important risk factor for hospitalization among older adults. Among community-dwelling older adults, functional

change was strongly related to future hospital use. (Mor, Wilcox, Rakowski, & Hiris, 1994). Among NH residents, the risk of hospitalization increased as ADL dependence increased (Fried & Mor, 1997; Murtaugh & Freiman, 1995). Worsening ADL trajectories increased the risk of mortality among long-stay nursing home residents (Kruse, Petroski, Mehr, Banaszak-Holl, & Intrator, 2013).

As expected, we found that the QI "incidence of worsening or serious ADL dependence" had a positive association and the QI "incidence of improved or maintained ADL independence" had a negative association with the risk of the hospitalization or death, even after we controlled for facility and other resident characteristics. We also found that the QI "incidence of improved or maintained ADL independence" was association with the lower risk of PPH.

5.4 Pressure sores

Pressure ulcers have serious health consequences for residents in long-term care facilities (Olsho et al., 2014). There is a consensus that pressure ulcer development is related to the quality of care (Berlowitz, Bezerra, Brandeis, Kader, & Anderson, 2000).Unresolved ulcers may require hospitalization. In the current study, the QI "prevalence of pressure sores in high-risk residents" was significantly related to the risk of hospitalization or death. Our finding was consistent with prior studies (Mary W Carter & Porell, 2006; Fried & Mor, 1997; Porell & Carter, 2005).

However, our study did not support the association between this QI and PPH, which is different from a previous study (M.W. Carter, 2003a). Our lack of an association may be explained by the low rates of hospitalization with diagnosis "skin ulcers and cellulitis", representing only 5% among all conditions used to define PPH.

5.5 Bladder continence

In current study, we found that the quality indicator "incidence of improving or maintained bladder continence" had a positive association with the risk of hospitalization or death, but not with the risk of potentially preventable hospitalization. This unexpected positive relationship may be explained by the association between continence and dehydration (Elstad, Maserejian, McKinlay, & Tennstedt, 2011; Hooper et al., 2015). Limiting fluid intake was used in NHs to manage urinary incontinence (Robinson, 2000). Fluid intake may be restricted in order to decrease the urinary output of incontinence and frequent requests for assistance (Drennan, Cole, & Iliffe, 2011; Kayser-Jones, Schell, Porter, Barbaccia, & Shaw, 1999). Research found that dehydrated residents had a higher risk of hospitalization (Wolff, Stuckler, & McKee, 2015).

5.6 Urinary tract infection

We also found that the quality indicator "prevalence of urinary tract infection" had a positive association with the risk of potentially preventable hospitalization, but not with the risk of hospitalization or death. Indeed, urinary tract infection is used to define PPH and accounted for nearly 12% among all those conditions.

5.7 Risk-adjusted quality indicators

We used the risk-adjusted quality indictors in the analysis to try to remove variance in quality indicators that can be attributed to differences between the types of residents served in NHs. Despite the generally recognition that risk adjustment is necessary to make NH comparisons fair, there is controversy surrounding risk adjustment because risk factors themselves might be the result of poor NH care. In current study, we first used a relatively conservative and short list of adjusters which probably would explain very little

of the variation in risk. We further controlled other resident characteristics and facility characteristics in the fully adjusted model. Regardless of risk adjustment, the results were consistent.

5.8 Limitations

The study has several limitations. First, our study only included nursing homes in Minnesota. The generalizability of these findings may be limited. More research is needed to test the relationship in other states. Second, the INTERACT programs were implemented during the study period. However, there is a great variation in its implementation across nursing homes. It is unfeasible to isolate its effect. Third, other unavailable information, such as advance directive and physician's preference may affect the relationship between QIs and hospitalization.

5.9 Policy implication

Most QIs address care needs (often related to nursing) that are believed to be part of good patient care, but this presumed good care here may not be related to hospital admission. Hospitals looking for discharge locations may place more emphasis on readmission rates than on nursing quality. It is less clear how consumers would value nursing quality against readmissions, but it is also not clear how much of a role they have in discharge decisions. Our study examined readmissions overall, not just 30-day readmissions, but it seems reasonable to assume the pattern would hold. We are essentially examining the relationship between two measures of NH quality performance.

5.10 Future research

First, the unexpected but interesting finding that the prevalence of antipsychotics was related to fewer hospitalizations deserves further investigation. Future research is needed

to investigate the factors driving prescribing decisions for antipsychotics and determine the role of organizational culture in medication prescribing in nursing facilities.

Second, the approximately 44% hospitalizations deemed potentially preventable can be grouped into three clinical categories. The first category includes conditions that would be preventable with better primary care preventing adverse events or management before an ensuring crisis. However, should they occur, they generally warrant a hospitalization. The second category, discretionary hospitalization, addresses conditions that are manageable within the nursing home. The third category, futile hospitalization, addresses end-of-life conditions when more care is unlikely to change the clinical trajectory. I plan to develop ways to identify each type of preventable hospitalization, explore factors contributing to these hospitalizations and create innovative initiatives to target these three pathways to reduce preventable hospitalizations.

Third, the findings indicate that quality indicators and hospitalization rates may tap different aspects of quality in nursing homes. Although the availability of selected quality indicators enables the consumer to begin to compare quality across facilities, broader outcome measures representing the overall state of quality such as rates of potentially preventable hospitalization are needed as well. There is little agreement about what risk factors should be selected for adjustment and how it should be carried out. I will explore the refinement of risk adjustment methods, such as using multilevel modeling, and treat risk more broadly in the context of care in nursing homes. Public reporting on risk-adjusted hospitalization rates could improve transparency and motivate nursing homes to improve quality while avoiding the unintended negative consequence of failing to transfer residents to hospital when medically necessary.

Fourth, a nursing facility may excel at some quality indicators and do poorly on other quality indicators. Under these circumstances a summary score will be hard to interpret. Preliminary factor analysis results on the available resident and facility level quality indicators suggest four main factors or domains (continence care, restraints and behavior problems, care for specific conditions, and physical functioning) to characterize facility performance. Using domains instead of individual items, can help facilities understand in what areas they are systematically weak. The domains may also help consumers, their families and advocates better choose nursing facilities. I will further investigate whether the factor score developed in the factor analysis would be a better way of identifying and rewarding high-performing facilities compared with individual quality indicator and a composite measure. I also want to explore the relationship between quality of care factors and quality of life factors to see what characterizes facilities that do well or poorly in both.

Tables and Figures

Table 1 The medical conditions used to investigate PPHs among NH residents in previous studies or reports

Conditions	Carter (2003)	Intrator (2004)	Grabowski (2007)	Walker (2009)	White (2009)	Young (2010)	Beck (2010)	Jacobson (2010)	Walsh (2010)	Kuo (2013)	Wysocki (2014)
Altered mental status, acute confusion, delirium									X		
psychosis, agitation , organic brain syndrome									X		
Anemia	X				X		X		X		
Angina	X	X	X	X		X	X	X		X	X
Asthma	X	X	X	X		X	X	X	X	X	X
Cellulitis	X	X	X	X		X	X		X	X	X
Chronic obstructive pulmonary disease	X	X	X	X		X	X	X	X	X	X
Congenital syphilis	X									X	
Congestive heart failure		X	X	X	X	X	X	X	X	X	X
Constipation,									X		

impaction											
Dehydration	X	X	X	X		X	X	X	X	X	X
Electrolyte imbalance					X						
Dental conditions	X			X			X			X	
Diabetes	X	X	X	X		X	X	X	X	X	X
Ear, nose, and throat infections	X	X	X			X	X			X	X
Epilepsy		X				X					X
Grand mal seizure disorders	X			X			X				
Grand mal status and epileptic convulsion			X							X	
Seizures									X		
Failure to thrive	X						X		X		
Weight loss and malnutrition									X		
Nutritional deficiency	X						X				
Gastroenteritis	X	X	X	X		X	X		X	X	X

Hypertension	X	X	X	X		X	X	X	X	X	X
Hypoglycemia	X	X	X	X		X	X		X	X	X
Immunization-preventable conditions	X						X			X	
Injuries from falls/fractures				X					X		
Kidney/urinary tract infection	X	X	X	X	X	X	X	X	X	X	X
Pelvic inflammatory disease	X						X			X	
Perforated or ruptured appendix								X			
Pneumonia		X	X	X		X	X		X	X	X
Respiratory infection					X						
Sepsis					X						
Septicemia				X							
Skin ulcers including pressure ulcer									X		
Tuberculosis	X						X	X		X	

Table 2 Domain, Name and Description of Minnesota Quality Indicators

Domain	Name of QI	Description	Process or Outcome
Physical Functioning	Incidence of Worsening or Serious ADL Dependence (Long Stay)	Percent of long-stay residents whose need for help doing basic tasks has increased or stayed at the highest level since the last assessment. These tasks include feeding oneself, moving from one chair to another, changing positions in bed and/or going to the bathroom. Residents with quadriplegia are not included in the calculation of this measure.	Outcome
	Incidence of Improved or Maintained ADL Independence (Long Stay)	Percent of long-stay residents whose need for help with basic tasks has decreased or stayed at the lowest level since the last assessment. These tasks include feeding oneself, moving from one chair to another, changing positions in bed, going to the bathroom, moving around the facility, getting dressed and/or personal hygiene.	Outcome
	Incidence of Walking as Well or Better than Previous Assessment (Long Stay)	Percent of long-stay residents who have the same or improved independence in walking ability since the last assessment.	Outcome
	Incidence of Worsening or Serious Mobility Dependence (Long Stay)	Percent of long-stay residents whose need for help moving in and around their room has increased or stayed at the highest level since the last assessment. Residents with quadriplegia are not included in the calculation of this measure.	Outcome
	Incidence of Worsening or Serious Range of Motion Limitation	Percent of long-stay residents whose ability to move the joints of their upper or lower extremities has declined or stayed at the lowest level since the last assessment. Residents	Outcome

	(Long Stay)	with quadriplegia are not included in the calculation of this measure.	
Accidents	Prevalence of Falls with Major Injury (Long Stay)	Percent of long-stay residents who have experienced one or more falls with major injury (e.g. bone fractures, joint dislocations, and closed head injuries with altered consciousness, subdural hematoma).	Outcome
Nutrition	Prevalence of Unexplained Weight Loss (Long Stay)	Percent of long-stay residents who have lost too much weight and are not on a physician-prescribed weight loss regimen.	Outcome
Skin Care	Prevalence of Pressure Sores in High-Risk Residents (Long Stay)	Percent of long-stay residents with a high risk for getting pressure sores that have one or more pressure sores. Residents are defined as high risk if they are comatose, malnourished , or have an impaired ability to move themselves in bed or transfer from bed to chair, etc.	Outcome
	Prevalence of New or Worsening Pressure Sores (Short Stay)	Percent of short-stay residents (recently admitted to the nursing home after a hospitalization) who have developed pressure sores or who had pressure sores that got worse since admission.	Outcome
	Incidence of Healed Pressure Sores (Long Stay)	Percent of residents who had a pressure sore that has healed.	Outcome
Psychosocial	Incidence of Worsening or Serious Resident Behavior Problems (Long Stay)	Percent of residents with verbal, physical, or other disruptive behavior symptoms that have worsened or have stayed at the most serious level since the last assessment.	Outcome
	Prevalence of Depressive Symptoms (Long Stay)	Percent of long-stay residents who are exhibiting signs of depression. This is determined by a standardized resident mood interview or if interview is not possible, by staff assessment.	Outcome

Psychotropic Medications	Prevalence of Antipsychotics Without a Diagnosis of Psychosis (Long Stay)	Percent of long-stay residents who receive an antipsychotic medication. Some residents with a serious mental illness diagnosis such as Schizophrenia are not included in the calculation of this measure.	Process
Quality of Life	Prevalence of Physical Restraints (Long Stay)	Percent of long-stay residents who were physically restrained. A physical restraint is any device, material or equipment attached or adjacent to a resident's body, that a resident can't remove easily, which keeps a resident from moving freely or prevents them normal access to their body. Side rails on beds are not included in this calculation.	Process
Infections	Prevalence of Urinary Tract Infections (Long Stay)	Percent of long-stay residents who had an infection in their urinary tract.	Outcome
	Prevalence of Infections (Long Stay)	Percent of long-stay residents who have had an infection. This may include drug-resistant infections, some wound infections, pneumonia, viral hepatitis, and septicemia.	Outcome
Continence	Incidence of Worsening or Serious Bowel Incontinence (Long Stay)	Percent of long-stay residents whose ability to control their bowel has gotten worse or stayed at the most serious level since the last assessment. Residents who need an appliance such as an ostomy for bowel movements are not included in the calculation of this measure.	Outcome
	Incidence of Worsening or Serious Bladder Incontinence (Long Stay)	Percent of long stay-residents whose ability to control their bladder has gotten worse or stayed at the most serious level since the last assessment. Residents who need an appliance such as catheter for urination are not included in the calculation of this measure.	Outcome
	Incidence of Improved or	Percent of long-stay residents whose ability to control their bowel has	Outcome

	Maintained Bowel Continence (Long Stay)	improved or stayed at the highest level since the last assessment.	
	Incidence of Improved or Maintained Bladder Continence (Long Stay)	Percent of long-stay residents whose ability to control their bladder has improved or stayed at the highest level since the last assessment.	Outcome
	Prevalence of Occasional to Full Bladder Incontinence Without a Toileting Plan (Long Stay)	Percent of long-stay residents who lose control of their bladder and are not on a documented individualized bladder toileting program.	Outcome
	Prevalence of Occasional to Full Bowel Incontinence Without a Toileting Plan (Long Stay)	Percent of long-stay residents who lose control of their bowel and are not on a documented individualized bladder toileting program.	Outcome
	Prevalence of Indwelling Catheters (Long Stay)	Percent of long-stay residents who had a catheter inserted and left in their bladder for a period of time.	Process
Pain	Prevalence of Residents who Report Moderate to Severe Pain (Short Stay)	Percent of short-stay residents (recently admitted to the nursing home following a hospital stay) who report having moderate to severe pain. Although pain is common during recovery and rehabilitation from a major illness or injury, it is still important to identify and treat pain.	Outcome
	Prevalence of Residents who Report Moderate to Severe Pain (Long Stay)	Percent of long-stay residents who reported having moderate to severe pain.	Outcome

	Incidence of Decrease in Pain When Admitted on a Pain Medication Regimen (Short Stay)	Percent of short-stay residents (recently admitted to the nursing home after a hospitalization) that were admitted on a pain medication regimen and are reporting a decrease in pain intensity or duration.	Outcome

Note: ADL=activity of daily living

Table 3 The severity and scope of a deficiency

Severity of the Deficiency	**Scope of the Deficiency**		
	Isolated	Pattern	Widespread
Immediate jeopardy to resident health or safety	J	K	L
Actual harm that is not immediate jeopardy	G	H	I
No actual harm with potential for more than minimal harm that is not immediate jeopardy	D	E	F
No actual harm with potential for minimal harm	A	B	C

*Shading indicates the ratings classified as substandard quality of care.

Table 4 Hypothesized Relationships between NH QIs and specific PPH diagnoses

Quality Indicators	**Specific PPH Diagnoses**
Incidence of worsening or serious ADL dependence	falls and trauma
Incidence of improved or maintained ADL independence	falls and trauma
Incidence of walking as well or better than previous assessment	falls and trauma
Incidence of worsening or serious mobility dependence	falls and trauma
Prevalence of falls with major injury	falls and trauma
Prevalence of unexplained weight loss	weight loss and nutritional deficiencies
Prevalence of pressure sores in high-risk residents	skin ulcers and cellulitis
Incidence of worsening or serious resident behavior problems	Psychosis, severe agitation, and organic brain syndrome
Prevalence of infections	pneumonia and bronchitis
Incidence of worsening or serious bowel incontinence	urinary tract infection
Incidence of worsening or serious bladder incontinence	urinary tract infection
Incidence of improved or maintained bowel continence	urinary tract infection
Incidence of improved or maintained bladder continence	urinary tract infection
Prevalence of indwelling catheters	urinary tract infection
Prevalence of urinary tract infections	urinary tract infection

Note: ADL=activity of daily living

Table 5 Nursing Home Characteristics

	Mean or N (%)	**Median (Interquartile range, IQR)**	**Min**	**Max**
Ownership				
For profit	100 (27.2%)			
Not for profit	226 (61.4%)			
Government	42 (11.4%)			
Hospital based	54 (14.7%)			
Urban	174 (47.3%)			
Part of a chain	191 (51.9%)			
Total beds	83	68 (51-100)	21	397
Proportion of single bed rooms	43.1	38.9 (18.8-65.0)	0	100
Staff				
Direct care staff hours per resident day	5.2	5.2 (4.8-5.6)	3.4	11.0
Direct care staff retention rate	73.2	73.4 (66.7-81.0)	27.9	100
Percentage of temporary/pool staff usage	0.3	0 (0-0)	0	13.2
Percentage of resident days covered by Medicaid	56.4	56.3 (48.6-64.1)	1.8	96.3
Percentage of resident days covered by Medicare	9.1	7.8 (5.4-11.0)	0	74.8
Percentage of resident days paid privately	26.6	26.6 (19.4-34.2)	0.4	74.5
Facility inspection rating, stars				
1 (lowest)	3 (0.8%)			
2	22 (6.0%)			
3	94 (25.8%)			
4	122 (33.5%)			
5 (highest)	123 (33.8%)			

Table 6 Resident Characteristics

	Mean ± SD or N (%)	**Median (IQR)**
Age	84.1 ± 9.4	85 (77-91)
65-69	2,263 (9.2%)	
70-74	2,480 (10.1%)	
75-79	2,883 (11.8%)	
80-84	3,923 (16.0%)	
≥ 85	12,981 (52.9%)	
Gender		
Female	17,855 (72.8%)	
Male	6,675 (27.2%)	
Race		
White non-Hispanic	22,137 (90.2%)	
Black non-Hispanic	888 (3.6%)	
Other	1,505 (6.1%)	
Marital status		
Married	4,513 (18.8%)	
Widowed, separated, divorced, or never married	19,498 (81.2%)	
Length of stay		
≤ 30 days	4,392 (17.9%)	
30-90 days	2,491 (10.2%)	
> 90 days	17,647 (71.9%)	
ADL score	2.5 ± 0.9	2.7 (2-3)
Independent	198 (0.8%)	
Supervision	2,510 (10.7%)	
Limited assistance	3,158 (13.5%)	
Extensive assistance	12,414 (52.9%)	
Total dependence	5,184 (22.1%)	
Depression severity (over the last 2 weeks)	3.9 ± 4.3	3 (0-6)
None	15,455 (66.8%)	
Mild	5,189 (22.4%)	
Moderate	1,703 (7.4%)	
Moderately severe	629 (2.7%)	
Severe	146 (0.6%)	
Cognitive performance	10.0 ± 4.6	11 (6-14)

Intact/borderline	7,769 (42.5%)	
Moderate impairment	4,832 (26.4%)	
Severe impairment	5,700 (31.2%)	
Pain or hurting (in the last 5 days)	11,032 (47.2%)	
End of life (life expectancy of less than 6 months)	1,160 (4.9%)	
Hospice care	1,330 (5.7%)	
Diagnoses		
Hypertension	17,315 (73.5%)	
Urinary Incontinence	12,293 (54.9%)	
Depression (other than bipolar)	11,832 (50.2%)	
Dementia	11,384 (48.3%)	
Bowel Incontinence	8,875 (38.2%)	
Diabetes Mellitus	7,827 (33.2%)	
Anemia	7,054 (29.9%)	
Heart Failure	6,482 (27.5%)	
Anxiety Disorder	5,624 (23.8%)	
Asthma, COPD, or Chronic Lung Disease	5,509 (23.4%)	
Coronary Artery Disease (CVD)	3,664 (21.2%)	
Cerebrovascular Accident (CVA), Transient Ischemic Attack (TIA), or Stroke	3,373 (14.3%)	
Delirium	2,422 (10.4%)	
Urinary Tract Infection (last 30 days)	2,026 (8.6%)	
Hemiplegia or Hemiparesis	1,852 (7.8%)	
Cancer	1,250 (7.1%)	
Psychosis	1,543 (6.6%)	
Seizure Disorder or Epilepsy	1,447 (6.1%)	
Parkinson's Disease	1,308 (5.5%)	
Pneumonia	1,123 (4.8%)	
Malnutrition	783 (3.3%)	
Manic Depression (bipolar disease)	709 (3.0%)	
Hip Fracture	699 (3.0%)	
Multidrug-Resistant Organism (MDRO)	382 (1.6%)	

Respiratory Failure	292 (1.2%)	
Would Infection (other than foot)	223 (0.9%)	
Septicemia	154 (0.7%)	
Entered from (during the study period)		
In the nursing facility (on Jan, 2011)	14,566 (59.4%)	
Hospital	8,200 (33.4%)	
Community	1,344 (5.5%)	
Other places	420 (1.7%)	

Notes :

a. ADL, activities of daily living. ADL score was the average score calculated based on eleven Minimum Data Set (MDS 3.0) items: bed mobility, transfer, walk in room, walk in corridor, locomotion on unit, locomotion off unit, dressing, eating, toilet use, personal hygiene, and bathing; range 0 to 4, with higher score indicating greater dependence. Based on the score, ADL self-performance was categorized into five groups: independent (= 0), supervision (0-1), limited assistance (1-2), extensive assistance (2-3), and total dependence (3-4).

b. Depression severity was measured using 9-item Patient Health Questionnaire (PHQ-9); range 0 to 27, with higher score indicating greater frequency bothered by these symptoms. Based on the score, depression severity was categorized into five groups: none (0-4), mild (5-9), moderate (10-14), moderately severe (15-19), and severe (20-27).

c. Cognitive performance was measured using the Interview for Mental Status (BIMS), which used MDS 3.0 items: repetition of three words, temporal orientation and recall items; range 0 to 15, with lower score indicating more severe cognitive impairment. Based on the score, residents were categorized into three groups: intact/borderline (13-15), moderate impairment (8-12), severe impairment (<8).

d. Delirium was assessed using the Confusion Assessment Method (CAM), which is a standardized instrument that has been developed to facilitate the detection of delirium.

e. Urinary and bowel incontinence were defined as frequently or always incontinent (score 2 or 3 on MDS 4-point scale) and continence was defined as always continent or occasionally incontinent (score 0 or 1 on MDS 4-point scale).

Table 7 Hospital Diagnosis

Hospital Primary Diagnosis Classes	**Number**	**Proportion**
Diseases of the respiratory system	1,447	21.81%
Diseases of the circulatory system	1,082	16.31%
Infectious & parasitic diseases	779	11.74%
Injury and Poisoning	686	10.34%
Diseases of the genitourinary system	606	9.13%
Diseases of the digestive system	558	8.41%
Endocrine, nutritional & metabolic diseases, and immunity disorders	266	4.01%
Symptoms, signs and ill-defined conditions	254	3.83%
Mental disorders	239	3.60%
Diseases of the nervous system and sense organs	229	3.45%
Diseases of the skin and subcutaneous tissue	164	2.47%
Disease of the musculoskeletal system and connective tissue	136	2.05%
Neoplasms	95	1.43%
Diseases of blood & blood-forming organ	70	1.06%
V-codes: factors influencing health status & contact with health services	22	0.33%
Congenital anomalies	2	0.03%

Table 8 PPH Diagnosis

PPH Diagnosis	**Number**	**Proportion**
Pneumonia and bronchitis (lower respiratory illness)	979	32.94%
Congestive heart failure	430	14.47%
Falls and trauma	378	12.72%
Urinary tract infection	345	11.61%
Dehydration, volume depletion including acute renal failure and hyponatremia	216	7.27%
COPD, chronic bronchitis, and asthma	186	6.26%
Skin ulcers and cellulitis	154	5.18%
Diarrhea, gastroenteritis, and C. difficile	88	2.96%
Seizures	50	1.68%
Anemia	42	1.41%
Hypertension and hypotension	32	1.08%
Psychosis, severe agitation, and organic brain syndrome	27	0.91%
Altered mental status, acute confusion, and delirium	22	0.74%
Constipation, fecal impaction, and obstipation	12	0.40%
Poor glycemic control	7	0.24%
Weight loss and nutritional deficiencies	4	0.13%

Table 9 Incidence/Prevalence Rates of Risk-adjusted Quality Indicators during the 2011-2012

Risk-adjusted Quality Indicators	**Mean (SD)**	**Median (IQR)**	**Min**	**Max**
Incidence of walking as well or better than previous assessment	77.0±9.3	77.1 (71.1-83.5)	41.5	99.8
Prevalence of occasional to full bowel incontinence without a toileting plan	75.1±23.0	83.9 (63.4-92.7)	1.1	99.7
Prevalence of occasional to full bladder incontinence without a toileting plan	59.1±26.0	62.2 (37.6-83.5)	1.6	99.5
Incidence of improved or maintained bowel continence	53.4±10.4	53.7 (46.7-59.7)	19.0	97.1
Incidence of healed pressure sores	53.0±16.9	52.1 (43.5-63.7)	9.8	98.9
Incidence of decrease in pain when admitted on a pain medication regimen (short stay)	50.1±12.9	50.6 (41.7-58.6)	9.7	84.9
Incidence of improved or maintained ADL independence	30.8±8.9	30.5 (25.3-35.5)	4.9	95.3
Incidence of improved or maintained bladder continence	27.6±8.5	27.1 (22.0-33.0)	0.9	66.2
Incidence of worsening or serious mobility dependence	27.5±10.8	26.8 (20.8-33.2)	0.2	77.1
Incidence of worsening or serious bowel incontinence	27.1±8.7	26.9 (21.4-32.3)	0.7	58.5
Prevalence of residents who report moderate to severe pain (short stay)	26.8±9.8	27.0(20.4-33.0)	0.6	68.2
Incidence of worsening or serious bladder incontinence	26.2±10.3	25.3 (18.6-32.4)	1.3	64.4
Incidence of worsening or serious ADL dependence	17.4±6.5	16.9 (13.1-21.4)	0.0	66.0
Prevalence of residents who report moderate to severe pain (long stay)	17.0±8.4	16.5 (10.9-21.9)	0.2	56.3
Incidence of worsening or serious resident behavior problems	14.1±7.5	13.1 (9.0-17.8)	0.3	65.4
Incidence of worsening or serious range of motion limitation	12.7±8.4	11.3 (6.9-16.6)	0.1	65.8
Prevalence of antipsychotics without a diagnosis of psychosis	11.5±7.6	10.5 (6.0-15.6)	0.1	68.9
Prevalence of unexplained weight loss	5.9±3.4	5.4 (3.5-7.6)	0.2	35.9
Prevalence of urinary tract infections	5.8±3.6	5.2 (3.2-7.7)	0.1	27.6
Prevalence of infections	4.6±4.0	3.6 2.0-6.0)	0.1	30.3

Prevalence of new or worsening pressure sores (short stay)	4.4±5.6	2.5 (1.2-5.0)	0.1	37.0
Prevalence of pressure sores in high-risk residents	4.1±2.3	4.0 (2.4-5.5)	0.1	23.9
Prevalence of falls with major injury	3.7±2.9	3.1 (1.4-5.2)	0.2	23.1
Prevalence of indwelling catheters	3.5±2.9	2.8 (1.2-4.8)	0.0	22.2
Prevalence of depressive symptoms	3.2±3.1	2.2 (0.9-4.4)	0.1	21.8
Prevalence of physical restraints	1.3±2.1	0.4 (0.2-1.7)	0.0	27.9

Table 10 Relationship between NH quality indicators and hospitalization /death

Outcome: Hospitalization & Death	**Unadjusted Model**		**Model adjusted for NH-level variables**		**Model adjusted for resident-level variables**		**Model adjusted for NH-level and resident-level variables**	
Quality Indicators	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Incidence of Worsening or Serious ADL Dependence	1.925	0.004	1.764	0.012	2.467	<0.001	2.317	<0.001
Incidence of Improved or Maintained ADL Independence	0.705	0.037	0.696	0.028	0.650	0.012	0.658	0.013
Incidence of Walking as well or better than previous assessment	0.582	0.001	0.705	0.025	0.724	0.043	0.799	0.157
Incidence of Worsening or Serious Mobility Dependence	1.194	0.261	1.312	0.084	1.128	0.451	1.179	0.301
Incidence of Worsening or Serious ROM Limitation	0.955	0.810	0.978	0.904	0.944	0.763	0.917	0.643
Prevalence of Falls with Injury	1.142	0.748	1.528	0.300	1.049	0.909	1.263	0.577
Prevalence of Unexplained Weight Loss	3.928	<0.001	3.641	<0.001	5.040	<0.001	4.461	<0.001
Prevalence of Pressure Sores in High Risk Residents	2.299	0.104	2.332	0.096	3.704	0.014	3.486	0.018
Prevalence of Antipsychotics w/o Dx	0.434	0.000	0.487	0.001	0.559	0.006	0.616	0.021

Incidence of Worsening or Serious Behavior Problems	0.720	0.091	0.771	0.181	0.735	0.121	0.715	0.090
Prevalence of Depressive Symptoms	1.546	0.308	1.598	0.280	0.721	0.458	0.620	0.286
Prevalence of Physical Restraints	0.884	0.857	0.994	0.993	1.353	0.662	1.295	0.706
Prevalence of UTIs	1.942	0.070	1.904	0.081	2.110	0.047	2.009	0.066
Prevalence of Infections	1.654	0.161	1.825	0.093	1.071	0.853	1.075	0.844
Incidence of Worsening or Serious Bowel Incontinence	1.126	0.602	1.043	0.854	1.204	0.428	1.177	0.488
Incidence of Worsening or Serious Bladder Incontinence	0.826	0.286	0.829	0.290	0.782	0.179	0.821	0.277
Incidence of Improving or Maintained Bowel Continence	0.929	0.686	0.919	0.645	1.098	0.618	0.986	0.939
Incidence of Improving or Maintained Bladder Continence	1.456	0.044	1.447	0.044	1.458	0.047	1.466	0.041
Prevalence of Occasional to Full Bladder Incontinence	0.968	0.696	0.945	0.475	0.966	0.672	0.959	0.595
Prevalence of Occasional to Full Bowel Incontinence	0.967	0.706	1.017	0.851	0.896	0.222	0.937	0.458
Prevalence of Indwelling	1.493	0.426	1.478	0.432	0.932	0.891	1.109	0.838

Catheters								
Prevalence of Moderate to Severe Pain (Short Stay)	1.375	0.029	1.529	0.003	1.165	0.305	1.299	0.076
Prevalence of Moderate to Severe Pain (Long Stay)	0.755	0.127	0.766	0.142	0.908	0.604	0.913	0.620

Table 11 Relationship between NH quality indicators and hospitalization

Outcome: Hospitalization	**Unadjusted Model**		**Model adjusted for NH-level variables**		**Model adjusted for resident-level variables**		**Model adjusted for NH-level and resident-level variables**	
Quality Indicators	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Incidence of Worsening or Serious ADL Dependence	1.749	0.136	1.655	0.176	2.387	0.025	**2.268**	**0.034**
Incidence of Improved or Maintained ADL Independence	0.864	0.596	0.866	0.598	0.749	0.319	0.830	0.516
Incidence of Walking as well or better than previous assessment	0.506	0.009	0.603	0.053	0.795	0.399	0.837	0.514
Incidence of Worsening or Serious Mobility Dependence	1.229	0.454	1.330	0.303	1.381	0.256	1.464	0.183
Incidence of Worsening or Serious ROM Limitation	0.814	0.545	0.801	0.504	0.842	0.620	0.752	0.404
Prevalence of Falls with Injury	1.732	0.401	2.229	0.220	1.815	0.377	1.848	0.362
Prevalence of Unexplained Weight Loss	4.316	0.014	3.949	0.021	8.674	0.001	**6.975**	**0.002**
Prevalence of Pressure Sores in High Risk Residents	3.519	0.114	3.891	0.088	7.581	0.016	7.017	0.021
Prevalence of Antipsychotics w/o Dx	0.222	<0.001	0.230	<0.001	0.305	0.002	**0.301**	**0.002**

Incidence of Worsening or Serious Behavior Problems	0.866	0.659	0.901	0.748	0.979	0.951	0.974	0.937
Prevalence of Depressive Symptoms	1.134	0.861	1.280	0.741	1.712	0.469	1.734	0.480
Prevalence of Physical Restraints	1.372	0.792	1.381	0.786	6.466	0.128	4.418	0.225
Prevalence of UTIs	3.594	0.034	3.414	0.042	3.777	0.035	3.174	0.068
Prevalence of Infections	2.511	0.123	2.608	0.108	2.647	0.116	2.187	0.208
Incidence of Worsening or Serious Bowel Incontinence	1.066	0.865	0.972	0.939	0.844	0.664	0.783	0.534
Incidence of Worsening or Serious Bladder Incontinence	1.268	0.428	1.168	0.602	1.360	0.325	1.376	0.306
Incidence of Improving or Maintained Bowel Continence	0.842	0.582	0.780	0.429	0.970	0.926	0.796	0.486
Incidence of Improving or Maintained Bladder Continence	2.419	0.005	2.456	0.004	2.576	0.004	**2.621**	**0.003**
Prevalence of Occasional to Full Bladder Incontinence	0.870	0.351	0.832	0.207	0.784	0.111	0.787	0.110
Prevalence of Occasional to Full Bowel Incontinence	0.880	0.428	0.998	0.989	0.762	0.099	0.844	0.295
Prevalence of Indwelling Catheters	1.480	0.648	1.682	0.543	1.480	0.658	1.992	0.436

Prevalence of Moderate to Severe Pain (Short Stay)	1.206	0.424	1.308	0.247	0.981	0.938	1.088	0.727
Prevalence of Moderate to Severe Pain (Long Stay)	1.668	0.099	1.641	0.107	1.734	0.083	1.675	0.102

Table 12 Relationship between NH quality indicators and PPH

Outcome: PPH	**Unadjusted Model**		**Model adjusted for NH-level variables**		**Model adjusted for resident-level variables**		**Model adjusted for NH-level and resident-level variables**	
Quality Indicators	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Incidence of Worsening or Serious ADL Dependence	1.657	0.332	1.658	0.325	2.029	0.187	2.099	0.160
Incidence of Improved or Maintained ADL Independence	0.461	0.043	0.493	0.060	0.352	0.009	**0.393**	**0.016**
Incidence of Walking as well or better than previous assessment	0.521	0.070	0.550	0.093	0.764	0.468	0.716	0.360
Incidence of Worsening or Serious Mobility Dependence	1.831	0.100	1.616	0.192	1.902	0.090	1.575	0.227
Incidence of Worsening or Serious ROM Limitation	0.798	0.616	0.698	0.408	0.730	0.493	0.603	0.252
Prevalence of Falls with Injury	1.857	0.504	2.174	0.398	1.593	0.623	1.628	0.603
Prevalence of Unexplained Weight Loss	6.298	0.026	5.217	0.043	11.445	0.004	**8.219**	**0.012**
Prevalence of Pressure Sores in High Risk Residents	3.276	0.302	2.797	0.368	4.699	0.197	3.255	0.320
Prevalence of Antipsychotics	0.207	0.002	0.214	0.002	0.307	0.021	**0.310**	**0.020**

w/o Dx								
Incidence of Worsening or Serious Behavior Problems	0.742	0.507	0.667	0.366	0.842	0.711	0.757	0.545
Prevalence of Depressive Symptoms	1.376	0.746	0.650	0.670	1.750	0.582	0.710	0.742
Prevalence of Physical Restraints	0.554	0.714	0.520	0.681	1.766	0.729	1.174	0.921
Prevalence of UTIs	8.363	0.011	6.977	0.020	7.055	0.024	**5.733**	**0.043**
Prevalence of Infections	2.727	0.217	2.815	0.199	2.644	0.246	2.304	0.314
Incidence of Worsening or Serious Bowel Incontinence	1.093	0.865	1.123	0.824	1.080	0.887	1.158	0.785
Incidence of Worsening or Serious Bladder Incontinence	1.891	0.123	1.834	0.137	1.886	0.140	1.933	0.117
Incidence of Improving or Maintained Bowel Continence	1.428	0.405	1.035	0.935	1.471	0.382	0.970	0.945
Incidence of Improving or Maintained Bladder Continence	1.938	0.123	2.032	0.091	1.746	0.208	1.856	0.151
Prevalence of Occasional to Full Bladder Incontinence	0.974	0.893	0.953	0.799	0.877	0.518	0.900	0.585
Prevalence of Occasional to Full Bowel Incontinence	0.665	0.057	0.749	0.163	0.635	0.037	0.699	0.086

Prevalence of Indwelling Catheters	2.322	0.466	2.538	0.413	1.972	0.567	2.558	0.418
Prevalence of Moderate to Severe Pain (Short Stay)	0.760	0.399	0.825	0.547	0.738	0.363	0.795	0.484
Prevalence of Moderate to Severe Pain (Long Stay)	2.705	0.019	2.285	0.047	2.396	0.043	2.065	0.085

Table 13 Relationship between certain QI and PPH defined by pneumonia and bronchitis

pneumonia and bronchitis	**Unadjusted Model**		**Model adjusted for NH-level variables**		**Model adjusted for resident-level variables**		**Model adjusted for NH-level and resident-level variables**	
QI	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Prevalence of Infections	41154.87	<0.001	3634.20	<0.001	9290.81	<0.001	935.16	<0.001

Table 14 Relationship between certain QIs and PPH defined by falls and trauma

falls and trauma	**Unadjusted Model**		**Model adjusted for NH-level variables**		**Model adjusted for resident-level variables**		**Model adjusted for NH-level and resident-level variables**	
QIs	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Incidence of Worsening or Serious ADL Dependence	39.926	<0.001	39.368	<0.001	30.435	0.001	**28.022**	**0.001**
Incidence of Improved or Maintained ADL Independence	0.215	0.053	0.339	0.180	0.323	0.163	0.394	0.259
Incidence of Worsening or Serious Mobility Dependence	5.427	0.010	3.023	0.103	3.829	0.047	3.023	0.115
Incidence of Walking as well or better than previous assessment	8.251	0.004	5.221	0.024	6.536	0.011	4.248	0.053
Prevalence of Falls with Injury	7783.287	<0.001	5186.837	<0.001	6877.256	<0.001	**5019.240**	**<0.001**

Table 15 Relationship between certain QIs and PPH defined by urinary tract infection

urinary tract infection	**Unadjusted Model**		**Model adjusted for NH-level variables**		**Model adjusted for resident-level variables**		**Model adjusted for NH-level and resident-level variables**	
QIs	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Prevalence of UTIs	760.772	<0.001	563.348	<0.001	728.794	<0.001	**795.424**	**<0.001**
Incidence of Worsening or Serious Bowel Incontinence	7.119	0.094	5.412	0.149	5.193	0.172	4.307	0.225
Incidence of Worsening or Serious Bladder Incontinence	0.687	0.661	0.772	0.758	0.855	0.859	1.007	0.994
Incidence of Improving or Maintained Bowel Continence	7.066	0.020	3.240	0.176	6.858	0.027	3.447	0.165
Incidence of Improving or Maintained Bladder Continence	2.593	0.282	2.889	0.220	1.719	0.556	2.011	0.437
Prevalence of Indwelling Catheters	249.556	0.009	65.542	0.047	518.405	0.004	**164.478**	**0.020**

Table 16 Relationship between certain QI and PPH defined by skin ulcers and cellulitis

skin ulcers and cellulitis	**Unadjusted Model**		**Model adjusted for NH-level variables**		**Model adjusted for resident-level variables**		**Model adjusted for NH-level and resident-level variables**	
QI	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Prevalence of Pressure Sores in High Risk Residents	166.668	0.178	85.600	0.244	38.397	0.358	25.799	0.415

Table 17 Fully adjusted models for the relationship between QIs and three outcomes

	Hospitalization & Death		**Hospitalization**		**PPH**	
Quality Indicators	**IRR**	**P value**	**IRR**	**P value**	**IRR**	**P value**
Incidence of Worsening or Serious ADL Dependence	2.317	<0.001	2.268	0.034	2.099	0.160
Incidence of Improved or Maintained ADL Independence	**0.658**	**0.013**	0.830	0.516	**0.393**	**0.016**
Incidence of Walking as well or better than previous assessment	0.799	0.157	0.837	0.514	0.716	0.360
Incidence of Worsening or Serious Mobility Dependence	1.179	0.301	1.464	0.183	1.575	0.227
Incidence of Worsening or Serious ROM Limitation	0.917	0.643	0.752	0.404	**0.603**	**0.252**
Prevalence of Falls with Injury	1.263	0.577	1.848	0.362	1.628	0.603
Prevalence of Unexplained Weight Loss	**4.461**	**<0.001**	**6.975**	**0.002**	**8.219**	**0.012**
Prevalence of Pressure Sores in High Risk Residents	3.486	0.018	**7.017**	**0.021**	3.255	0.320
Prevalence of Antipsychotics w/o Dx	**0.616**	**0.021**	**0.301**	**0.002**	0.310	0.020
Incidence of Worsening or Serious Behavior Problems	0.715	0.090	0.974	0.937	0.757	0.545
Prevalence of Depressive Symptoms	0.620	0.286	1.734	0.480	0.710	0.742
Prevalence of Physical Restraints	1.295	0.706	4.418	0.225	1.174	0.921
Prevalence of UTIs	2.009	0.066	3.174	0.068	**5.733**	**0.043**
Prevalence of Infections	1.075	0.844	2.187	0.208	2.304	0.314
Incidence of Worsening or Serious Bowel Incontinence	1.177	0.488	0.783	0.534	1.158	0.785
Incidence of Worsening or Serious Bladder Incontinence	0.821	0.277	1.376	0.306	1.933	0.117

Incidence of Improving or Maintained Bowel Continence	0.986	0.939	0.796	0.486	0.970	0.945
Incidence of Improving or Maintained Bladder Continence	**1.466**	**0.041**	**2.621**	**0.003**	1.856	0.151
Prevalence of Occasional to Full Bladder Incontinence	0.959	0.595	0.787	0.110	0.900	0.585
Prevalence of Occasional to Full Bowel Incontinence	0.937	0.458	0.844	0.295	0.699	0.086
Prevalence of Indwelling Catheters	1.109	0.838	1.992	0.436	2.558	0.418
Prevalence of Moderate to Severe Pain (Short Stay)	1.299	0.076	1.088	0.727	0.795	0.484
Prevalence of Moderate to Severe Pain (Long Stay)	0.913	0.620	1.675	0.102	2.065	0.085

Figure 1 The relationship between QIs and hospitalization/PPH

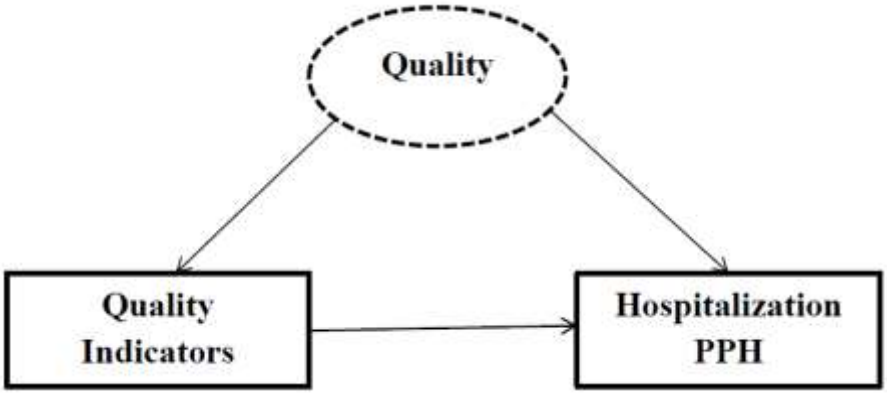
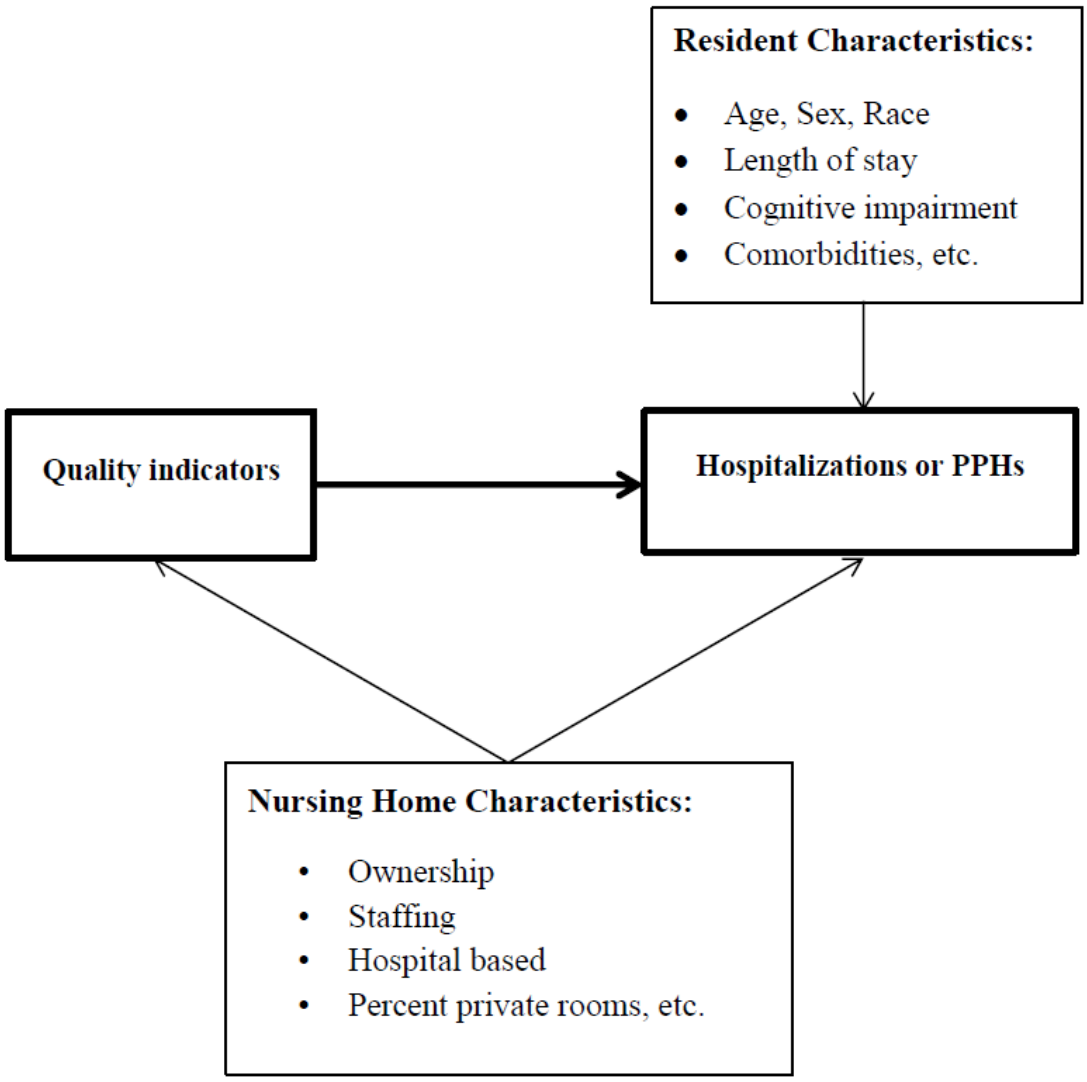


Figure 2 Conceptual Model



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Appendix

Appendix A The ICD-9 diagnosis codes to define PPH

Conditions	ICD-9 diagnosis codes
COPD, chronic bronchitis, and asthma	466–466.99, 490–490.99, 491.0, 491.1, 491.2, 491.20, 491.21, 491.8, 491.9, 492.0, 492.8, 493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.20, 493.21, 493.22, 493.81, 493.82, 493.90, 493.91, 493.92, 494–494.99, 496–496.99
Congestive heart failure	398.91, 402.11, 402.91, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9, 518.4
Constipation, fecal impaction, and obstipation	564.0, 564.00, 564.01, 564.09, 560.39
Dehydration, volume depletion including acute renal failure and hyponatremia	276.1, 276.5, 276.8, 584.0–584.99, 588.8, 588.81, 588.89, 588.9
Hypertension and hypotension	401.9, 402.10, 402.90, 403.10, 403.90, 404.10, 404.90, 458.0, 458.1, 458.2, 458.21, 458.29, 458.8, 458.9
Poor glycemic control	251.2, 250.2–250.29, 250.3–250.39, 250.1–250.19, 251.0, 250.02, 250.03, 790.29
Seizures	345–345.99, 436–436.99, 780.3– 780.39
Urinary tract infection	590.10, 590.11, 590.81, 590.9, 595.0, 595.1, 595.2, 595.4, 590.80, 595.89, 595.9, 597.0, 598.0–598.09, 599.0, 601–601.99
Weight loss (failure to thrive) and nutritional deficiencies	260–260.99, 261–261.99, 262– 262.99, 263–263.99, 268.0, 268.1, 783.21, 783.22, 783.3, 783.7
Altered mental status, acute confusion, and delirium	290.3, 290.41, 292.81, 293, 293.0, 293.1
Anemia	280.0–280.99, 281.0–281.99, 285.20– 285.29, 285.9
Diarrhea, gastroenteritis, and C.difficile	003.0, 004–004.99, 005–005.99, 006.0, 007.0– 007.99, 008–008.99, 009–009.99, 558.9, 787.91
Falls and trauma	800–805.08, 805.10, 805.11, 805.12, 805.13, 805.14, 805.15, 805.16, 805.17, 805.18, 805.3, 805.5, 805.6, 805.7, 805.9, 806–829.99, 830–839.99, 850–852.00, 852.03, 852.04, 852.10, 852.12, 852.13, 852.14, 852.15,

	852.16, 852.19, 852.20–853.00, 853.03, 853.04, 853.09–854.99, 905–905.99, 906–906.99, 907– 907.99, 908–908.99, 909–909.99, 925–929.99, 940–949.99, 958.9–959.99, 991.6–991.99, 992.0–992.99, 993.5–993.79, 994.1–994.39, 994.7–994.89
Pneumonia and bronchitis (lower respiratory illness)	480–480.99, 481–481.99, 482–482.99, 483.0–483.9, 485–485.99, 486–486.99, 507.0
Psychosis, severe agitation, and organic brain syndrome	290.42, 290.43, 290.8, 290.9, 293.81, 293.82, 293.83, 293.84, 293.89, 293.9, 295.2, 297–297.99, 298–298.99
Skin ulcers and cellulitis	681–681.99, 682–682.99, 683–683.99, 686–686.99, 707.0– 707.09, 707.1–707.19, 707.8, 707.9

Note: COPD= chronic obstructive pulmonary disease